MAX 7000AE Performance Comparison

MAX ON BOARD

Introduction

The Altera® MAX® 7000 device family is the industry's fastest and most preferred product-term solution. Now, with MAX 7000AE devices, performance is enhanced even more to help designers meet today's high-performance demands in a variety of systems.

To show the high performance of MAX 7000AE devices, Altera conducted a benchmark test that compared the MAX 7000AE device to the Xilinx XC9500XL device and the Lattice ispLSI2000VE device. This technical brief describes the results of the benchmark test.

Performance Estimates Using Data Sheet Numbers

Performance estimates can help you determine the maximum device performance for most designs. You can easily calculate the performance of a device by using the internal timing parameters found in the device family data sheet.

Generally, device vendors use a maximum internal clock frequency, f_{CNT}, to measure performance. In most designs, this f_{CNT} represents the highest performance a device can achieve. To calculate f_{CNT}, four timing delay elements must be known: the register delay (t_{RD}), the programmable interconnect delay (t_{PIA}), the logic array delay (t_{LAD}), and the register setup time (t_{SU}). Figure 1 shows these timing delays and the equation used to calculate the f_{CNT}.

Figure 1. Timing Delays & f_{CNT} Equation   *Note (1)*
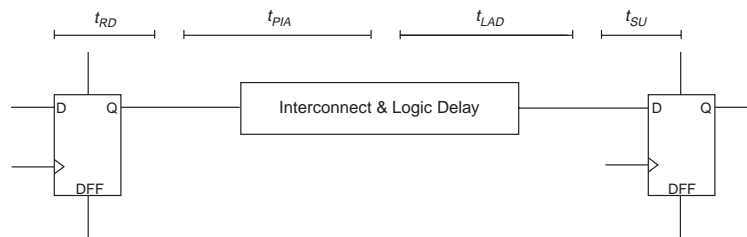
$$\text{Internal } f_{CNT} = \frac{1}{t_{RD} + t_{PIA} + t_{LAD} + t_{SU}}$$

Note:
(1)   To calculate the f_{CNT}, device vendors use the register-to-register feedback path of a standard 16-bit counter.

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Table 1 shows the delay elements and f_{CNT} for the Altera EPM7128AE device, the Xilinx XC95144XL device, and the Lattice ispLSI2128VE device.

Table 1. Delay Elements & f_{CNT} Comparison   *Note (1), (2)*

Vendor	Device	t_{RD} (ns)	t_{PIA} (ns)	t_{LAD} (ns)	t_{SU} (ns)	Total Delay (ns)	Internal f_{CNT} (MHz)
Altera	EPM7128AE-5	0.8	1.4	1.6	1.4	5.2	192
Xilinx	XC95144XL-5	0.4	1.9	1.0	2.3	5.6	179
Lattice	ispLSI2128VE-180	0.3	0.6	3.4	1.2	5.5	182

Notes:
(1) The delay element names differ for each device. The timing delays t_{RD}, t_{PIA}, t_{LAD}, and t_{SU} are names used by Altera. Equivalent delay names for each device are as follows: Xilinx XC95144XL-5: t_{CO1}, t_F, t_{LOGI}, t_{SU}; and Lattice ispLSI2128VE-180: t_{GCO}, t_{GRP}, t_{1PTXOR}, and t_{GSU}.
(2) All values were taken directly from each device's respective data sheet.

Table 1 shows that the Altera EPM7128AE device has the highest f_{CNT} at 192 MHz. This data sheet result suggests that the EPM7128AE device provides the highest performance for most designs.

Benchmark Experiment

Although device data sheets provide a good source of information about the general performance of a device, benchmark tests that implement real customer designs remain the most reliable measurement of performance. Customer designs are normally complex in nature, exercising both the logic resources of a device and the compilation software. The data sheet f_{CNT} calculation result does not adequately represent the complexity of customer designs.

In a recent benchmark study of 23 customer VHDL designs, Altera Applications compared the performance of the Altera EPM7128AE device to the Xilinx XC95144XL device and the Lattice ispLSI2128VE device. All designs were compiled in the fastest speed grade for each device. Table 2 provides a brief description of the resources used in each design.

Table 2. Customer VHDL Designs Used in Benchmark Test (Part 1 of 2)

Design	Average Macrocells Used	I/O Pins Used
1	115	72
2	126	61
3	108	72
4	128	49
5	128	70
6	114	49
7	115	66
8	118	73
9	128	35
10	126	73
11	114	80
12	120	59
13	90	73
14	110	66
15	91	78
16	70	51

Table 2. Customer VHDL Designs Used in Benchmark Test (Part 2 of 2)

Design	Average Macrocells Used	I/O Pins Used
17	106	75
18	96	94
19	93	55
20	126	62
21	121	78
22	105	81
23	108	39

Table 3 shows the synthesis and place-and-route tools used for the test.

Table 3. Tools Used in the Benchmark Test   *Note (1), (2)*

| Device	Synthesis	Place & Route
EPM7128AE-5	Synopsys FPGA Compiler II version 3.2.0	Altera MAX+PLUS II version 9.4
XC95144XL-5	Synopsys FPGA Compiler II version 3.2.0	Xilinx WebPack version 2.1WP2.x
ispLSI2128VE-180	Synopsys FPGA Compiler II version 3.2.0	Lattice ispEXPERT version 7.1

Notes:
(1)   All designs were compiled using the fastest synthesis settings.
(2)   If a design did not fit, optimization settings were applied.

EPM7128AE & XC95144XL Device Results

Figure 2 shows the performance comparison between the Altera EPM7128AE device and the Xilinx XC95144XL device. Both devices successfully fit all 23 customer designs; however, the EPM7128AE device outperformed the XC95144XL device in 17 customer designs. Overall, the EPM7128AE device performed 30% faster than the XC95144XL device.
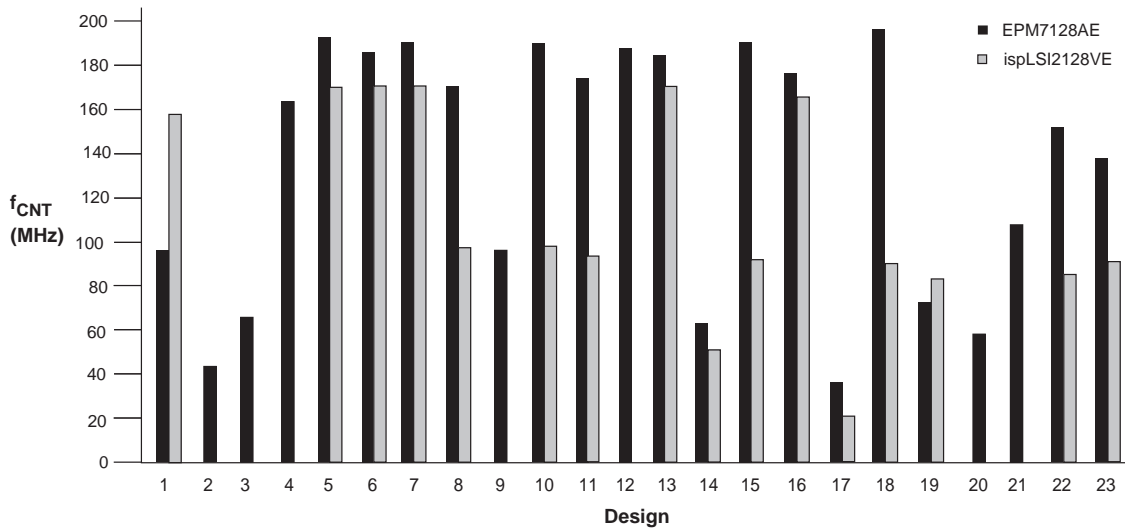
Figure 2. EPM7128AE & XC95144XL Comparison
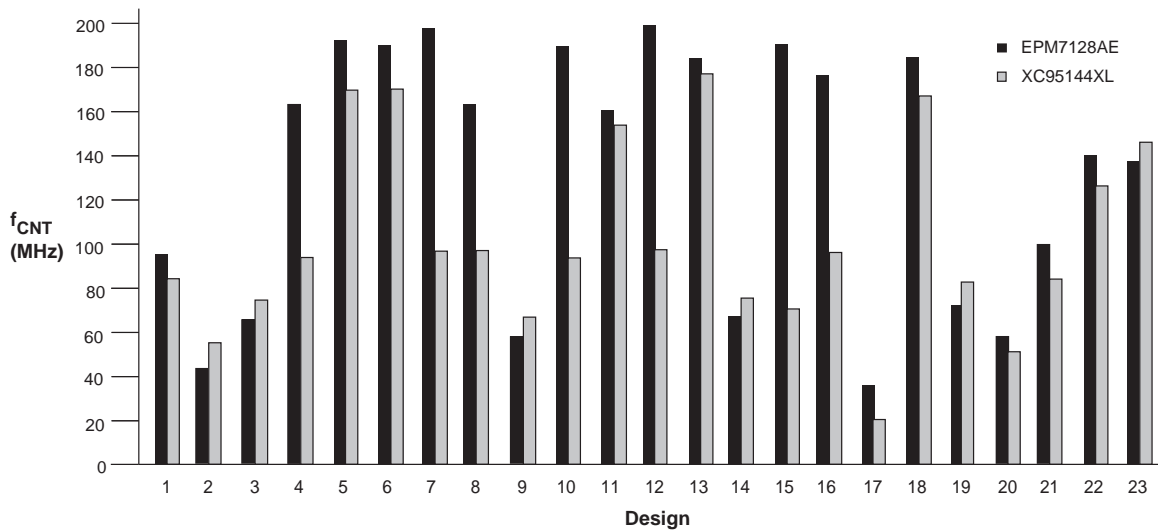
EPM7128AE & ispLSI2128VE Device Results

Figure 3 compares the performance of the Altera EPM7128AE device and the Lattice ispLSI2128VE device. The ispLSI2128VE device successfully fit only 16 of the 23 customer designs. The EPM7128AE device outperformed the ispLSI2128VE device in 14 of those 16 designs. Overall, the EPM7128AE device performed approximately 40% faster than the ispLSI2128VE device.

Figure 3. EPM7128AE & ispLSI2128VE Comparison   Note (1)

Note:
(1)   If a gray bar is missing from the graph, the Lattice ispLSI2128VE device failed to fit that design.

The Industry's Fastest Product-Term Solution

MAX 7000AE devices continue to lead the industry with the fastest product-term solution. When comparing performance estimates of the Altera EPM7128AE device to the Xilinx XC95144XL device and the Lattice ispLSI2128VE device, the EPM7128AE device has the highest internal f_{CNT}. This result indicates that the EPM7128AE device provides the highest performance for most designs.

For a thorough performance comparison between the devices, Altera Applications conducted a benchmark study of 23 customer designs. The results of the benchmark test showed that the Altera EPM7128AE device performed, on average, 30% faster than the Xilinx XC95144XL device and 40% faster than the Lattice ispLSI2128VE device. The EPM7128AE device clearly outperforms its competition by providing the highest performance solution to today's complex designs.